Modernization of the Worldwide Military Command and Control System

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PREFACE

The head of the Air Force Systems Command, General Bernard Randolph, requested the Air Force Studies Board (AFSB) to examine the Worldwide Military Command and Control System (WWMCCS) Information System (WIS) program, which had in 1989 been terminated and transferred from Air Force to Defense Communications Agency management by the Office of the Secretary of Defense. General Randolph retired before the AFSB could begin the study. His successor, General Ronald Yates, encouraged the AFSB to proceed with the study.

The AFSB assembled a committee of individuals skilled in acquisition management, information systems, and military command and control. The committee held conferences in Washington, D.C., and Bedford, Massachusetts, during which it interviewed and received briefings from the WIS program managers and key personnel from both of the program management organizations, both major contractors, and key system users.

The report is intended to provide a series of lessons to be learned from the WIS program that may help preclude such problems in the future.

To the many who generously provided information and ideas and shared their experiences over the course of the study, the committee expresses its thanks.

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EXECUTIVE SUMMARY

The Worldwide Military Command and Control System (WWMCCS) has served as the principal vehicle for communication between the Joint Chiefs of Staff (JCS) and the operational commands of the U.S. Armed Forces since the 1970s. In its original form WWMCCS was a large network of mainframe computers that facilitated centralized control of the widely dispersed U.S. force structure. The system was managed as a joint asset by the Defense Communications Agency (DCA) and functioned as an online open channel for the large volume of routine communications (i.e., unit readiness reports, logistics and support inventories, local conditions, etc.) that are the foundation of day-to-day and contingency planning.

The WWMCCS network came to maturity in the early 1980s when computer networking and software technologies were on the verge of a revolution. The direct implications of this for WWMCCS were not clear, but it seemed to promise a more flexible and interactive system that would convey more detailed (and therefore more usable) information to both the JCS and the commands. From these motivations sprang the WWMCCS Information System or WIS.

Leadership of the WIS program was assigned to the Air Force in 1982. The service erected a WIS management organization, which later that year announced an architectural scheme for the program that included a Local Area Network (LAN), an Automatic Message Handling System (AMHS), and a joint operational planning and evaluation capability. By 1988 each of these WIS subsystems was several years behind schedule, prompting the Office of the Secretary of Defense to suspend the program and transfer management of it from the Air Force to DCA.

The budgetary and technological environments in the early 1980s contributed to getting WIS off to an uncertain start. Each service was rushing to launch programs in time to take advantage of the prevailing support for increased defense spending. At the same time, all of the core technologies that would support the WIS program were *beginning* a dramatic transformation. Careful program management was necessary to protect WIS from these potentially destructive influences.

At the same time, the Department of Defense (DoD) was encouraging the use of Commercial Off-The-Shelf (COTS) technology, particularly in computer and information systems. This inclination, along with limited

computer experience among the senior management corps in the Pentagon, further hampered the WWMCCS modernization program.

The Air Force anticipated many of these bureaucratic and technical obstacles and designed the organizational scheme accordingly. To cope with the diverse and evolving user expectations common in multiservice efforts, a Joint Program Management Office (JPMO) was established to referee the system requirements process and guide WIS through the planning, programming, and budgeting system. The JPMO was essentially the bureaucratic arm for the WIS program. Technical functions, including system engineering and contractor relations, were to be *coordinated* by a System Program Office (SPO). Proper communication -- between the two offices, as well as between each one and its natural constituency -- would ensure that contractors fulfilled the users' requirements.

However, transferring this management concept into practice proved difficult. The original system architecture for WIS was conceived by the SPO with input from the program's System Engineering and Technical Assistance (SETA) consultant, the MITRE Corporation, Washington, D.C. User needs were not well documented or coordinated and a requirements baseline was not established or controlled. Consequently, major technical risks, which originated as unrealistic user expectations, were not recognized when the WIS architecture was being defined. For example, the SPO regarded the standing DoD policy of encouraging the use of COTS products as an immutable directive rather than as a baseline requirement that could be revised if found to be technically infeasible. The technical risks associated with the initial conception of WIS thereby became embedded in the program as contractually mandated end items.

Bureaucratic problems were also embedded in the WIS acquisition process. Delegation of some program management responsibility to a system-level contractor is particularly essential when attempting a complex upgrade to an existing Command, Control, Communications, and Intelligence (C^3I) system. However, while the WIS SPO did include system integration functions in the LAN contract issued to General Telephone and Electronics (GTE), it failed to provide the commensurate authority to perform this role. {International Business Machines (IBM) was awarded the common user contract, which primarily provided for work on the AMHS.} Without adequate integration authority, GTE took no action to change or modify the COTS requirement in the WIS architecture. The SPO, which was the de facto system integrator, lacked the technical expertise to

recognize the risks involved in mandating COTS and elected to adhere to the original bureaucratic directive.

The committee identified three primary management failures in the WWMCCS modernization program.

1. Fundamental principles of business and management were misunderstood, violated, or simply ignored. This was exemplified by:

a. the divided program management, which caused unnecessary competition, confusion, communication problems, and contradictory guidelines; and

b. assignment of lead agency responsibility to the Air Force as opposed to DCA, which had developed and was operating the existing system.

2. Technical challenges were grossly underestimated (i.e., COTS technology was mandated, but not available). This was exemplified by:

a. the mid-stream decision to switch the high-level programming language from COBOL to Ada; and

b. the decision to pursue a LAN architecture that would involve several unproven technologies and approaches (i.e., a dynamically switching network employing both token-ring and Ethernet-type formats and use of strict DoD security provisions on a nominally COTS system).

3. Efforts to shorten or bypass the established systems acquisition process frequently resulted in a failure to perform the system engineering analyses that are essential to a C^3 modernization program. This was exemplified by:

a. the failure to revise the baseline system requirements and architecture as technical obstacles emerged;

b. the failure to provide adequate responsibility to the assigned system integration contractor; and

c. (in lieu of adequate responsibility) the failure to provide the integration contractor with proper guidance -- for example, complete system engineering analyses from the SETA consultant.

Lessons Learned

1. *Assign management of major programs to a single manager with requisite authority and responsibility.*

2. *Assign management of information system upgrades to the organization that operates or manages the existing system.* If this is not done, the management organization must be a principal participant in the definition of the upgrade.

3. *Conduct comprehensive analyses of the current and projected operational environment of the system, including other systems with which it will interoperate.*

4. *Ensure that initial system requirements are based on well conceived needs that have been approved by the user.* This is particularly important when there are many and varied users.

5. *Review the system engineering process of the existing system while performing impact analyses for the upgrade.* This analysis should look far enough forward to consider specific hardware and software end items, facilities requirements, and skills and training required for operating, maintenance, and management personnel.

6. *Record and document the system engineering process and the evolution of requirements in order to ensure traceability.*

7. *Do not place constraints on the system architecture (i.e., mandating a specific programming language or the use of COTS technology) until system engineering analyses have been completed.*

8. *Exercise special management and acquisition options such as incremental system development and preplanned product improvements when programs seek to tap rapidly evolving technologies.* To field capable information systems on time, the Defense Department must work near -- but not at -- the leading edge of emerging technology.

9. *Encourage open-system-architecture approaches.*

10. *Design and circulate a clear acquisition strategy.* The acquisition strategy for large information system upgrades should be piece-wise (evolutionary) in order to accommodate rapidly changing technology and user requirements. The acquisition strategy must be based on a comprehensive risk assessment. The risk assessment must be regularly updated, with significant changes reflected in alterations to the acquisition plan.

11. *Investigate the commercial marketplace to determine if COTS products meet system requirements before issuing solicitations.* If modifications to COTS items are required, the potential contractors should recommend changes to system requirements that would make unmodified COTS items viable. These must then be evaluated through the system engineering process in order to reestablish cost, schedule, and performance estimates. Include COTS technology in formal solicitations only if this analysis is acceptable. If the impacts are not acceptable, recognize that a developmental effort is required and reflect it in the Request For Proposals (RFP).

12. *Specify system integration responsibility and assign adequate authority in the formal acquisition plan.* Retaining system architecture and integration responsibility in the program office requires resources and skills that are not typically available there.

13. *Avoid issuing firm fixed-price contracts unless system requirements are stable and impose no technological uncertainties.*

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INTRODUCTION AND BACKGROUND

The Worldwide Military Command and Control System (WWMCCS) has served as the principal vehicle for communication between the Joint Staff and the operational commands of the U.S. Armed Forces since the 1970s. The system is managed by the DCA and consists of second-generation computer main-frames at approximately 40 command centers in the U.S. and abroad. However, within a few years after the WWMCCS network was completed, the *perception* of the state of the art in computer connectivity, data handling, and information security had evolved dramatically. Plans were soon drafted to modernize WWMCCS through equipment and software upgrades. From those plans sprang the WWMCCS Information System or WIS.

As a command-level information and communications network, WIS would have to be a joint program. However, as the only service to maintain the nucleus of its C^3I assets for deployed forces at the permanent command centers, the Air Force was best able to exploit the surplus computing capability that would be available beyond the core WIS functions. The Air Force thus was assigned program responsibility and announced a successive, three-stage acquisition strategy:

1. *Block A* would provide the hardware necessary to modernize WWMCCS, specifically the LAN, the AMHS, and the WIS workstations.

2. *Block B* would supply the software to activate the Joint Operational Planning and Evaluation System (JOPES), elevating WIS from an information network to a near-real-time system that would allow the Commanders in Chief and the National Command Authority to exercise day-to-day control over the widely dispersed U.S. force structure.

3. *Block C* would expand the capabilities of both Blocks A and B, but was largely undefined.

TABLE 1 Chronology of the WWMCCS Modernization Program*

Late 1970s	WWMCCS installation complete at approximately 40 military command locations worldwide.
Nov 1981	WIS JPMO is established in response to a memorandum by the deputy Secretary of Defense dated November 5, 1981. The JPMO is originally headed by a two-star Air Force general, reporting directly to the Air Force Acquisition Executive. (This post is later downgraded to a colonel billet.) JPMO eventually grows to a staff of 70.
July 1982	The JPMO reports to Congress on the WWMCCS modernization program.
Sept 1982	The Secretary of Defense issues the formal charter for the JPMO.
Dec 1982	The WIS SPO is established at the Electronic Systems Division (ESD), Hanscom Air Force Base, Bedford, Massachusetts, as part of a catch-all or "basket" SPO that manages several other programs.
Dec 1982	The WIS SPO issues an acquisition plan.
Oct 1983	SPO contracts with GTE for preliminary system design, planning, and integration.
Oct 1984	SPO contracts with IBM for development of the AMHS.
July 1985	The milestone schedule presented at the first Defense Systems Acquisition Review Council meeting on WIS indicates that early products (i.e., personal-computer-based work stations) are to be delivered by the end of fiscal year (FY) 1987; the AMHS is slated for delivery by the end of FY 1988. Research, development, test, and evaluation (RDT&E) for the program is budgeted for $423 million through FY 1987, with an additional $350 million anticipated to be spent through FY 1991.

Nov 1987	Citing gross management errors and the failure to receive contract deliverables, Congress cuts FY 1988 funding for WIS to $21 million, effectively killing the program.
April 1988	In an attempt to revive WIS, the joint program director proposes a major restructuring to the assistant Secretary of Defense (ASD/C^3I). ASD C^3I requests DCA to review the program.
Jan 1989	DCA recommends terminating all WIS contracts, without deliverables.
March 1989	An OSD acquisition decision memorandum cancels the Air Force-led WIS program, and directs transfer of the effort to DCA. (DCA renames the program WWMCCS Automated Data Processing [ADP] Modernization or WAM.)

*Some of the chronology is derived from a report issued by the WIS JPMO on April 1, 1989.

WIS development was initiated in 1982, and by 1988 the Block A and B schedules had slipped two to three years. As a result of these delays, the assistant Secretary of Defense (C^3I) and the JCS recommended transferring management of WIS from the Air Force to DCA. They directed DCA to attempt a gradual system upgrade with an "open architecture" philosophy and to emphasize the use of commercially available hardware and software to fulfill in small increments the essential JOPES role. The Defense Acquisition Board (DAB) approved the transfer of management authority on February 10, 1989. The chronology in Table 1 outlines some of the events in the WIS program that foreshadowed that decision.

To appreciate these events, it is useful to recall the political and budgetary environment that confronted program managers when the WWMCCS upgrade was launched. Each service was rushing to get programs under way while the new bipartisan support for increased defense spending lasted. Moreover, the Reagan administration's endorsement of high-profile weapon systems (i.e., the B-1 bomber, stealth aircraft, and strategic defense) was matched by strong support for modernization of the C^3I infrastructure. Nevertheless, WIS program managers knew that any future cutback would likely target infrastructure first.

The technological environment in which the WWMCCS upgrade was conceived was also extremely turbulent. At their most basic level, the core technologies that would support the effort -- computer hardware, software, and communications -- were *beginning* a transformation that would yield products and processes bearing little resemblance to those of the previous generation. These possibilities, which included distributed architectures of small computers, multiple-access networks, and a DoD-exclusive programming language, became the standard for WIS. The degree of technical risk that this placed on the program was not well understood and handicapped it from the start. WIS was considered to be an upgrade, which by definition is a modification to an existing and proven system; in fact, it involved many undertakings for which no precedents existed.

The Study

Following the demise of WIS, Gen Bernard Randolph, Commander of the former Air Force Systems Command (AFSC), asked the National Research Council's Air Force Studies Board to examine the program. He requested that the study derive "lessons learned" that might benefit future efforts to develop large-scale, technically advanced systems. The Board proposed to review the WIS experience as a policy-level case study of defense technology management. The study committee would neither audit the organizations that managed the program nor seek to assign responsibility for the problems uncovered; rather, it would attempt to derive lessons for managing technology development programs that face changing and uncertain requirements. With this in mind, AFSC outlined the following tasks:

1. Review the requirements and original program objectives for the WIS. Review whether these changed and, if so, how frequently. Review the motivation for these changes.

2. Review the WIS management strategy and the adherence by the program office to that plan.

3. Assess the status of the technology and systems development at the time the program was transferred to the DCA.

4. Determine the key elements of strategic management that contributed significantly to the WIS experience.

Chapter 2 reviews the early management scheme established for WIS, and identifies flaws in conceptualization and program design that contributed to its ultimate demise. Chapter 3 considers the acquisition and integration phase of the program during which the WIS management strategy was executed. This section includes a discussion of how the management strategy evolved over time leading to the decision to abort the effort. Chapter 4 considers lessons learned from the WIS experience that might benefit future advanced C^3I programs.

To fulfill the charter, the Air Force Studies Board assembled a committee of ten individuals collectively skilled in acquisition management, information systems, and military command and control. The committee, which convened in both Washington, D.C., and Bedford, Massachusetts, interviewed and received briefings from WIS program managers, key personnel in the management organizations, the two major contractors, and the user community. Though the study began more than a year after WIS had been terminated, the recollection of program principals was excellent. Without exception they were extremely forthcoming. However, to protect their anonymity, the report does not attribute comments or viewpoints to particular individuals.

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INITIAL PROGRAM DESIGN

BACKGROUND

Acquisition Strategy in the Early 1980s

By 1980 the systems acquisition process had evolved into a complex mechanism for apprising top Pentagon managers of program progress and included frequent reports, briefings, and formal reviews. When in the 1960s it generally took 4 to 6 years to move a system through the RDT&E cycle and reach an initial operational capability, complex management regulations had driven the process closer to 10 years. To reduce development time, and consequently procurement costs, the Office of the Secretary of Defense (OSD) began to mandate the use of COTS technology whenever possible. Nowhere was this policy more evident throughout the 1980s than in the acquisition of computer and information technology, which is usually considered to have large overlaps between civilian and military applications.

The COTS approach presumes that integrating known products will be less costly and risky than developing entirely new system components. The policy also assumes that unique military standards -- such as stricter security provisions -- can be satisfied through relatively minor modifications. However, systems engineers testified to the committee that neither the initial compatibility nor the integration of COTS hardware and software can be taken for granted. Considering COTS programs to be a matter of simply "plugging in the pieces" can lead managers to underestimate the complexity and technical risk involved.

Programs that attempt to upgrade existing information and communication systems also face some unique problems. Unlike weapon systems, which typically operate as stand-alone platforms, essential command and control (C^2) networks cannot be modernized in blocks; they must continue to operate as a unit throughout a progressive upgrade. What is more, operational commanders recognize that software-programmed C^2 systems

lend themselves to modification to meet special needs. It is therefore common for new command staffs to review existing or planned C^2 assets and revise previously established requirements.

The WIS program was confronted by each of these obstacles: there were indications that Congress would not approve a unique military hardware development program; OSD required that it exploit COTS; it was an upgrade of a complex, existing C^2 system; and requirements were changing continually. Later sections illustrate that the acquisition strategy for WIS did not account for these factors.

Qualifications of In-House Personnel

Most military officers above the rank of captain, like their civilian management counterparts in the early 1980s, had little computer training. Throughout the services, acquisition programs that involved computer and information technology suffered from a lack of technical expertise among senior management personnel. Nevertheless, it is typically senior management that has the most direct line of communication with the user community and must convey its needs. As later sections of this report demonstrate, this dispersed computer literacy yielded several mistakes in the initial design of the WIS program.

Services' Views of WWMCCS and WIS

Though joint-service acquisitions were not rare in the 1980s, many of the programs that were intended to harmonize C^2 across the armed forces (i.e., the Tri-Service Tactical Communication system and the Joint Tactical Information Distribution System) were handicapped by conflicting requirements or a lack of uniform interest. The established function of WWMCCS in the chain of command hierarchy also did not foster much enthusiasm for WIS in the three services. According to some regional service commanders, WWMCCS data formats did not permit explanation of minor deviations from full operational capability. In general, a system by which one's superiors measure one's performance is seldom warmly embraced. As a consequence, WIS did not have a natural sponsor among the armed services. Only the Air Force, which was in the best position to take advantage of the extra computing capability that would be available, expressed any interest in WIS. The JCS and top OSD management, on

the other hand, considered WIS essential to a global force projection strategy.

Baseline System Requirements

Uncertain requirements are a constant problem in military research and development contracting. If there are many users with different perspectives, which is characteristic of large information management systems, identifying commonalities and resolving differences is a formidable, yet essential, task. User requirements must be coordinated, approved, converted to system specifications, and further developed into RFPs that provide detailed guidelines for hardware and software deliverables. If a program aims to improve an existing system, the developmental process, which derives specifications from user requirements, must take into account the baseline system and design a feasible transition plan.

Initial or baseline assessments of program requirements -- particularly for information and communication systems -- should not call for specific hardware or software solutions. They should merely identify the users of the system, define missions, and describe existing and expected operational needs. The initial statement of needs should not be expected to endure throughout the RDT&E cycle; rather, it must be constantly updated in response to evolving user requirements and technical lessons learned. The WIS Joint Mission Element Need Statement (JMENS), which was one of the earliest planning documents for the WWMCCS upgrade, reflects this: "WWMCCS functional user needs and requirements are being refined and documented. ...This is an iterative process that will continually update system specifications."[1] The uncertainty in requirements was apparently ignored in the development of the acquisition strategy and choice of contractual relationships.

Criteria for a Sound Program Architecture

An architecture is ordinarily organized in a way that reflects the highest-level functional or physical partitioning of the system. A top-level

[1] WIS JMENS, Section D, Assessment of Need, 1979.

definition of functions for a system such as WIS might be subdivided to include:

1. software architecture (relevant open-system standards, programming languages, operating systems, integrity criteria, software maintenance criteria);

2. hardware architecture (relevant guiding standards, computers, peripherals, computer links, local communications networks, global networks, interfaces to existing or standard networks);

3. data handling architecture (relevant guiding standards, data conversion, processing, data exchange, user interface definition, models or criteria); and

4. security architecture (relevant guiding standards, encryption, physical protection, security criteria for selection of COTS hardware and software).

In some cases, additional architectural elements (i.e., human interface or safety considerations) may be separately identified. This is common when such aspects are essential to the application.

The features identified above should encompass the components for the final system to be implemented. For each feature or interface defined, the architect should identify (a) the required capability, (b) a preferred approach, and (c) several acceptable alternatives. The objective of the architecture is to delineate a unified whole. Since the overall quality of an information system is often subject to the weakest-link limitation, the architect must specify quality and compatibility expectations for each part of the system.

The architect should follow a disciplined System Requirement Analysis (SRA) approach to guarantee that the solution and the contract deliverables will be supported by a documented and controlled requirements baseline. If incremental improvements are anticipated or desired, the architect should select an application design that can be partitioned via individual functional capabilities or separately acquired and integrated into an existing overall system capability.

Software is a critical element in the architectural design. Operating system software transforms the raw machine into a more responsive facility

that responds to system calls to handle input, output, and storage access. Run-time software transforms the underlying hardware and software into a "virtual machine" that responds to commands compiled from a given programming language. Application software then transforms the underlying system into one adapted to a particular user's needs. It is important to find the layer in the hardware/software hierarchy that is common to the widest variety of expected applications, and to develop the final information system architecture at that layer.

PROGRAM MANAGEMENT

The Initial Division of Labor

The Air Force was assigned management responsibility for WIS by then Deputy Secretary of Defense Frank Carlucci whose memoranda of November 5, 1981, February 9, 1982, and September 22, 1982, defined the program's initial organization. The management structure established in these documents did not evolve significantly over the life of the program. The 1988 chart of WIS organizational relationships, depicted in Figure 1, mirrors the original program scheme outlined by Carlucci. The division of program management authority and responsibility between a joint program management office and a system program office, which was the hallmark of the WIS organization, was intended to facilitate a multi-service effort with evolving requirements. The JPMO would concentrate on top-level management issues, leaving the SPO free to coordinate the system architecture and acquisition. In this way, the Carlucci directives sought to enforce a delicate compromise between the needs of a joint program, which is typically expected to generate conflicting requirements and guidelines, and the needs of a complicated C^3I system, which demands close attention to system modeling, architecture, and integration.

Subsequent to the Carlucci memoranda, the WIS JPMO was established in McLean, Virginia. His guidance stipulated that the JPMO report through the Air Staff to the Air Force Acquisition Executive. The WIS SPO was simultaneously installed at the AFSC's ESD in Bedford, Massachusetts.

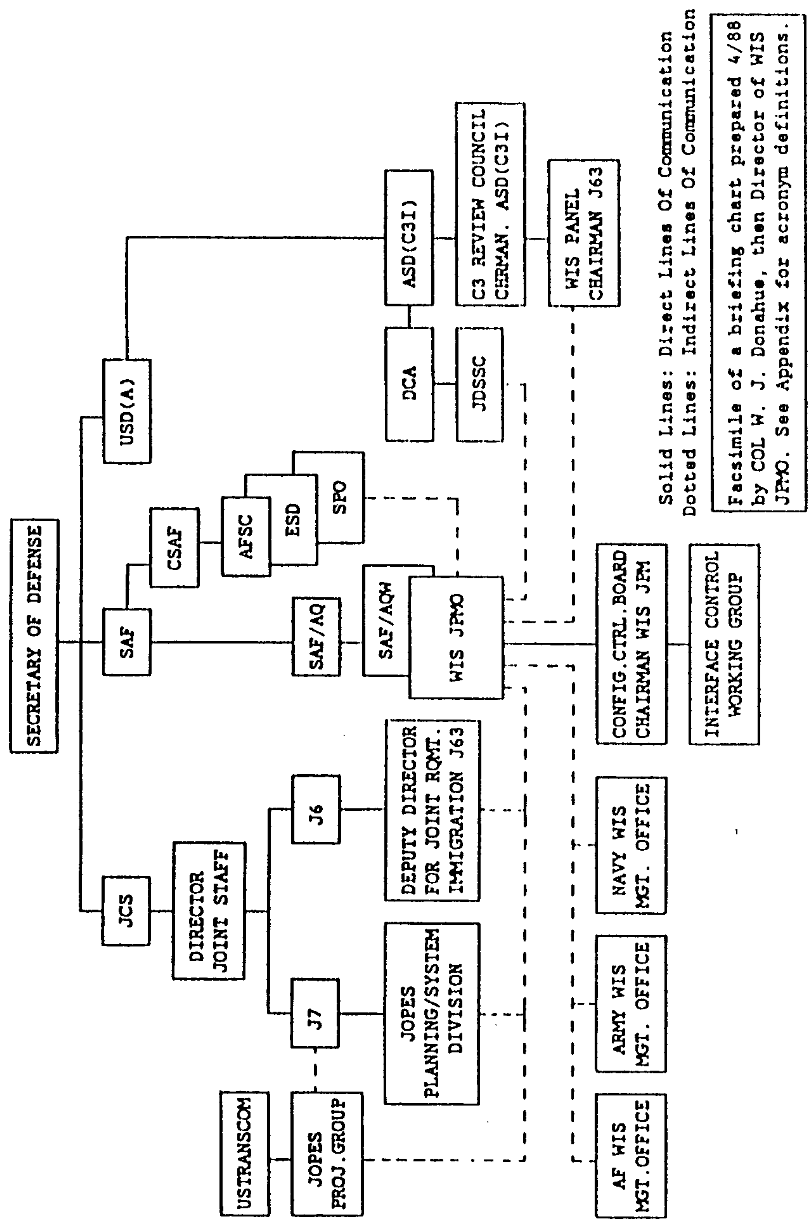


FIGURE 1 : WIS Organizational Relationships as of April 1988

Evolution of the WIS Architecture

The WIS architecture evolved from a series of uncoordinated Air Force, JPMO, and SPO directives. From key documents and briefings, the committee identified several tasks that were fundamental to the WIS effort. Each was mentioned before January 1982 and eventually became the responsibility of the integration contractor. Together they constitute a de facto architectural plan for WIS:

1. Develop and deliver an overall system description and evolution guide.

2. Develop and deliver site integration and system security plans.

3. Develop and deliver a functional description of a LAN and identify the necessary interfaces.

4. Support all installation and test of computer equipment and services at the Development and Evaluation Facility.

5. Develop and deliver a baseline functional description of the WIS network-accessible database.

However, since the integration contractor was never tasked or funded to do the underlying system engineering work, the WIS architecture was ad hoc from the start.

The original WIS acquisition plan, issued by the System Program Office in December 1982, states:

> The WIS will upgrade WWMCCS Automated Data Processing (ADP) host processors at 21 sites. ... At each site, an authorized user at a workstation will have access to local and remote WIS functions. ... [The integration] contractor will ... develop and deliver a functional description of a LAN and identify necessary interfaces. ... The common user contractor will ... procure modern computer host for the common user subsystem, ... procure terminals to support the common user subsystem and to

> Interface with the LAN, [and] deploy the common user subsystem hardware and software base in WWMCCS field sites.[2]

The acquisition plan also discusses a Joint Mission Hardware Contract for "...hosts, peripherals and system software... [with] LAN and common user subsystem interfaces." Other WIS requirements documents did not mention features such as LANs and terminals.

After the initial architecture emerged from SPO, the additional system engineering functions that are integral to the program definition phase (i.e., refining baseline system specifications and connecting requirements with specific contract end items) were never performed. Subsequent developments therefore lacked top-down guidance, often proceeding at cross purposes. For example, failure to conduct crucial system engineering analyses in the program definition phase led the WIS SPO to unwittingly contract for a proprietary COTS processor that would be incompatible with the chosen vendor-specific network.

Unlike its architecture, the WIS deployment strategy can be described as evolutionary (see Table 2). Block A involved state-of-the-art hardware upgrades, but these would still not include replacement of the WWMCCS mainframe computers. Even though Blocks B and C were to provide improved operational capabilities, the overall design was revolutionary in nature and characterized by heavy reliance on developmental hardware and software. And despite the provision in WIS contracts for upgrading only 21 of the WWMCCS sites, new message handling protocols would have dictated conversion of the entire network at once. Since this evolutionary plan was not based on a coherent overall architecture, it was doomed even before the earliest deliveries. Nothing other than some inconsequential "early" products emerged from the program.

The WIS Program Blueprint and Contractor Response

Within a year after its founding, the WIS SPO had produced a program plan that described the following major contractual elements: (1) an integration contract, (2) a common user contract (primarily addressing the message handling system), (3) an independent software validation and verification contract, and (4) a joint-mission hardware contract. GTE won the integration contract in October 1983. A year later IBM was awarded the common user contract. The software validation contract was issued much later and had no substantial impact on WIS. The final contract for replacement of the obsolete WWMCCS computers was never awarded.

TABLE 2 The Four Planned Phases of WIS Procurement

1. "Early Products"
   - workstations
   - commodity (COTS) software
2. Block A
   - AMHS
   - LAN
   - Ada software development environment
3. Block B
   - JOPES (increment I)
   - Joint hardware and the database management system
   - Upgrades to Block A Capabilities to support this
4. Block C
   - Remaining application software
   - Network accessible database
   - Upgrades to Blocks A and B to support these features

Both GTE and IBM were under guidance to employ COTS elements to the greatest extent possible. Development of the LAN selected by GTE would depend on untried, proprietary designs, including broadband coaxial transmission cables, a unique WIS protocol, and a combination of collision (i.e., Ethernet) and a noncollision (i.e., token ring) multiple-access network schemes. The two networking modes were to be dynamically switched in response to traffic level. The security architecture chosen by GTE would attempt to marry multilevel security strategy with a LAN monitor control

[2] ESD SPO, WIS Acquisition Plan (PX-82-1), December 3, 1982.

system to provide authentication and access to the system. Multilevel secure gateways were also planned to control external access.

IBM conformed to the COTS prescription by selecting a commercial IBM mainframe to support its AMHS software. IBM's proposed message handling subsystem, roughly equivalent to an electronic mail network, was said to be based on its maintenance and system software, which had been developed for the private marketplace. IBM believed this would need very little manipulation to meet WIS requirements. The company similarly expected its mainframe approach to endure.

As the following sections demonstrate, the failure of both these contractor efforts was rooted in major errors in the initial management of WIS. Chapter 3 then considers the question of why, amid mounting pressure to produce results and with so little to show, the badly flawed WIS program strategy was pursued to the end.

FAILURES IN EARLY PROGRAM MANAGEMENT

Acquisition Strategy Not Suited to a System Update

Unless there are compelling reasons to the contrary, supervision of modernization programs is assigned to the organizational entity that manages the existing system. Nevertheless, the committee found that OSD never considered assigning the WIS upgrade to the DCA, which had developed and was operating the original WWMCCS network. DCA was more familiar with COTS computer and information systems than either ESD or MITRE and was the natural choice.

Divided Organizational Structure

In 1982 the Secretary of Defense issued a charter for the JPMO that established it at a level above and outside the normal Air Force acquisition structure. This action compounded the separation of program management responsibilities between the JPMO and SPO. Although an earlier memorandum from the deputy Secretary of Defense (February 9, 1982) states that the WIS joint program manager "...will have cognizance over all portions of the WWMCCS system," the dimensions and implications of that responsibility were not defined.

The divided program management violated the first rule of good acquisition management: assign responsibility, authority, and funding for a program to a single manager who is, in turn, accountable for the success or failure of the program. Every major study of systems acquisition management (i.e., Commission on Government Procurement, Packard Commission, etc.) has come to this general conclusion. Uncertainty about where the ultimate program management authority rested left those attempting to fulfill the role with incomplete information and conflicting directives. What is more, the split management structure short-circuited the normal and necessary lines of communication between program management and users, designers, and contractors. This further frustrated efforts to correct the original problems that developed in the design phase.

SPO's Low Priority Within Its Local Command

The high priority accorded the JPMO, together with the much lower priority given the SPO, resulted in a marked imbalanced in staffing at these offices. The JPMO was overstaffed, with greater numbers and higher-level officers than necessary. The SPO, on the other hand, did not have adequate personnel to support its assigned functions. The officers it did have lacked the seniority or technical experience needed to direct such a complicated and bureaucratically complex program. ESD assigned WIS to what was referred to as a "basket SPO" -- two levels deep in the ESD organizational structure. Buried in this low post, the program managers there could not be expected to administer effectively the acquisition of a system of WIS's complexity, magnitude, and cost.

Rapid Technology Evolution Ignored

There was a general failure throughout the WIS management structure to comprehend the implications of the rapidly evolving state of the art in information systems networking. Efforts to shorten the acquisition cycle of WIS in order to keep pace with the supporting technology were largely unsuccessful. Omission of a contract definition phase did save time, but led the two major WIS contractors -- GTE and IBM -- to pursue perceived COTS solutions that careful systems modeling and architectural analysis

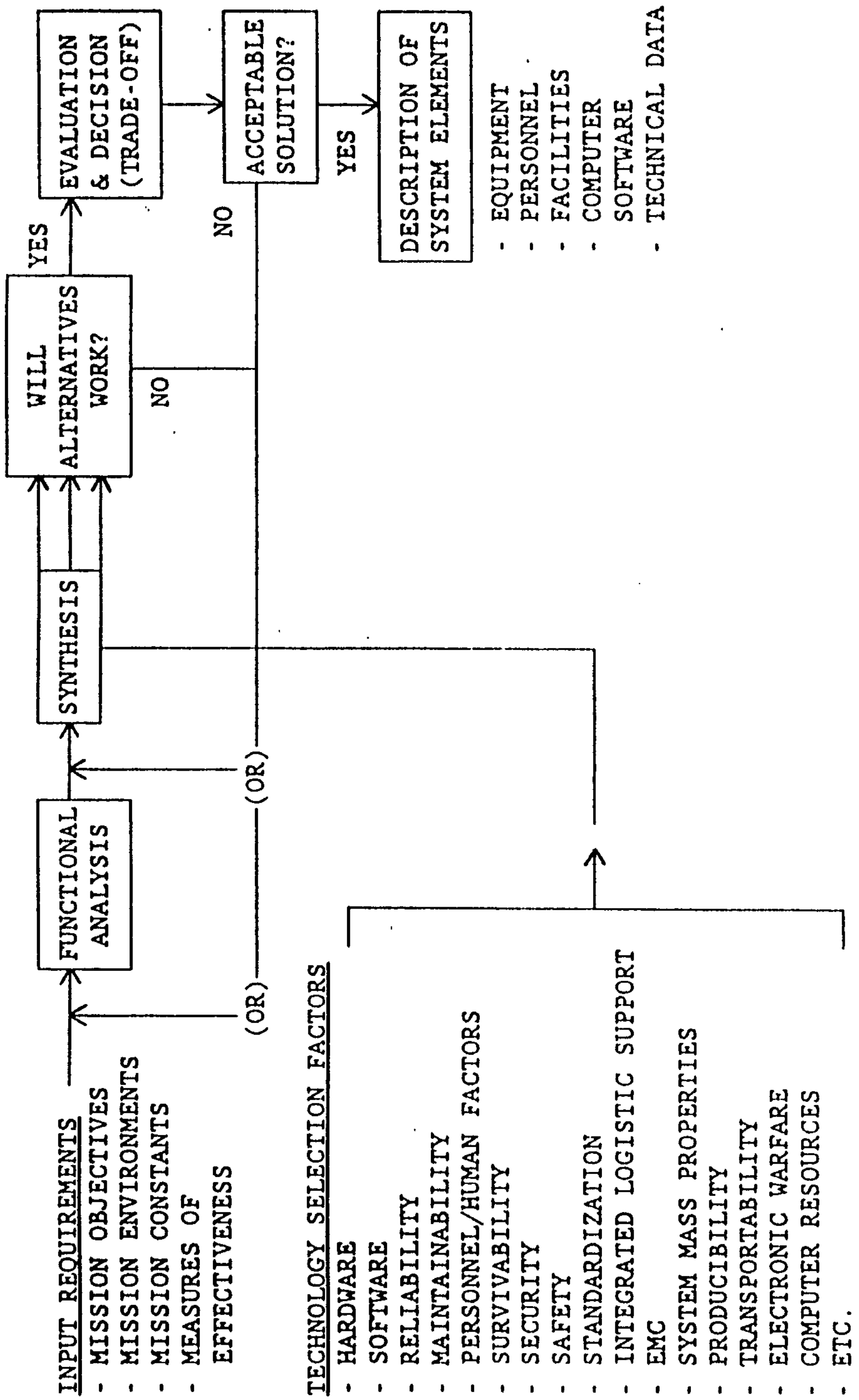


FIGURE 2 : The System Engineering Process

would have shown to be infeasible for a secure network. Building WIS on an unproven technical foundation was a critical management failure.

Standard System Engineering Processes Not Followed in Developing the Initial Acquisition Strategy

The standard system engineering process outlined by the DoD (see Figure 2) includes:

1. performing a SRA;

2. evaluating alternatives through modeling and cost-benefit tradeoff studies;

3. selecting the most viable alternative;

4. revising baseline specifications; and

5. developing an acquisition strategy.

WIS managers bypassed or subverted this process, establishing a system architecture and end-item specifications without performing the necessary system engineering analyses. WIS organizational documents indicate that SPO was supposed to rely on the MITRE Corporation for SETA. In interviews conducted by the committee, program management officials could not detail MITRE's role in WIS, including (1) its assigned responsibilities, (2) its early interaction with the program offices and the integration contractor, and (3) its reaction to the considerable technical risk embedded in the WIS architecture.

A SETA consultant under contract (i.e., MITRE) should not have to be prompted to perform its stated function. The committee also learned that a SRA was never performed. This is supported by the fact that MITRE personnel were unable to trace the origin of the COTS requirement, which should have been documented in an SRA. It would have been appropriate for MITRE to protest the inadequate system engineering and design, but there was no evidence that it did so.

3

EXECUTION OF THE WIS ACQUISITION STRATEGY

As detailed in chapter 2, the initial program strategy developed in the first year left WIS ill-prepared to meet and overcome the technical and bureaucratic challenges inherent in all major defense system acquisitions. However, despite its inauspicious beginning, WIS was not destined to fail. When the initial WIS acquisition strategy was issued by the SPO no hardware or software had yet been procured. The execution phase of the program yielded its own crop of program management errors, which are the subject of this chapter.

LACK OF COMMUNICATION BETWEEN THE AIR FORCE AND DCA

The DCA was clearly disappointed that it had not been selected to coordinate the WIS program. Nevertheless, the Air Force officers assigned to manage WIS did not attempt a reconciliation with DCA in the interest of improving the chances that the program would succeed. Cooperation between the DCA manager of WWMCCS and the WIS SPO was minimal throughout the course of the program. In the field, WWMCCS was evolving slowly as its users' requirements and direction changed. Meanwhile, the JPMO and SPO pursued WIS as an independent system development; direct user involvement and future operations and maintenance concerns of DCA were being deferred until the hardware and software were completed. If the lessons learned by DCA in its years of developing and operating WWMCCS had been tapped, the Air Force might have avoided many of the problems that plagued WIS; perhaps, too, the lessons-learned exercise embodied in this report might have been unnecessary.

WIS INTEGRATION

The SPO contracted with GTE for the integration work and for reliability, maintainability, and supportability technologies. GTE's WIS group

reported that it was given neither the authority nor the information to do the system integration job. In fact, the acquisition plan for WIS (PXS-82-1) did not recognize the complexity of the integration problem. Although the integration contractor was tasked to "develop and deliver an overall WIS description and evolution guide" and to "... identify the necessary interfaces," GTE *had no authority* to identify and define interfaces with other WIS contractors or with the manager of WWMCCS.

The acquisition plan states that, in the follow-on effort, the integration contractor will "support the government contractual efforts as it enhances the following: automated message handling, user terminal services ... and communications services including local user-to-user exchanges." This statement implies that the SPO always intended to serve as system integrator, with some documentation support and advice from the integration contractor and, presumably, SETA support from MITRE.

By March 28, 1986, more than two years after the integration contract was awarded, GTE sent a 12-page memorandum to the SPO requesting a contract modification that would provide the requisite authority. The memorandum was never answered. MITRE also was never asked to perform any system engineering or integration functions. Those system integration tasks that were authorized in GTE's contract were only implemented when hardware and software were about to enter the operational test and evaluation phase. This was too late to have any effect on hardware and software specifications under contract for development.

The role of the JPMO in dealing with the contractors was indirect. In their briefings to the committee, contractor representatives indicated that the JPMO informally requested them to use Ada and network-based multilevel security. (Formal directives still reflected the baseline system specifications.) Though the contractors appear to have recognized that the JPMO did not have contractual authority over their work, they told the committee they were reluctant to disregard any input from an organization to which their contract supplier was presumed to report. The SPO and the JPMO spoke with different voices, leaving GTE to wonder whether to follow the changing requirements or the money.

COTS HARDWARE AND ADA

The original RFPs for both the LAN and the AMHS stipulated the use of COTS hardware and software. At some point during the WIS program, OSD directed the services to adopt Ada (a recently developed, defense-specific programming language) in all "embedded" systems for which developmental software and hardware were used. Though Ada had been defined by 1977, the OSD determination that Ada not be implemented in subsets required every compiler to handle the complete language. This increased the cost and delayed development of compilers. Consequently, when IBM began encountering difficulties implementing the WIS AMHS in COBOL (another OSD-approved programming language) and switched to Ada, there was no Ada compiler for the IBM 360; one had to be developed before IBM could proceed.

Contractor Responses to the COTS Requirements

IBM and GTE tried to meet the demands in their contracts for COTS technology, but had only partial success. In some cases, both hardware and software had to be modified to meet the COTS requirements. The SPO's unwavering support for COTS technology escalated the WIS program costs, extended schedules, and eventually yielded only a few contract deliverables, most of which did not even meet the users' requirements.

An IBM briefer told the committee the government's insistence on COTS equipment led the company to propose commercial solutions that it realized would not fulfill contract specifications. In fact, the committee believes that in the early phases of WIS there were no COTS solutions to the AMHS and LAN requirements. According to this briefer, IBM told the Air Force that the company's next-generation personal computer, which would largely meet WIS requirements, was about to be introduced commercially, but at a higher unit price. The SPO elected to stick with the current generation of COTS terminals (based on IBM PC/XT computers), expecting to have to invest only a little more time and money to bring the system up to specification. IBM began to develop the necessary changes, but found the modified XT to be less reliable. IBM later resolved to substitute -- without a contract amendment -- its next-generation AT computer for the XT as soon as the new system was available in the

private sector. According to the IBM representative, this move cost the company approximately $16 million.

Beyond the unsuccessful attempts to incorporate COTS hardware and software, the committee noted several other harmful product deviations permitted by the SPO's weak technical management. Some of these are detailed below.

Midcourse Change to Ada

IBM's decision roughly midway through the WIS program to switch from COBOL to Ada further damaged its contract performance. IBM had fallen behind its software schedule and proposed to switch to Ada even though the necessary compiler and software-development utilities were not available. IBM briefers told the committee they were under considerable pressure from "elements of the Defense Department" to use Ada. The SPO and MITRE insist they opposed IBM's programming language change, but the committee could find no documentary evidence. For its part, IBM told the committee that it expected at the time to recover the software development schedule by virtue of improved programming efficiency provided by Ada. The company now admits this was a major error.

Unproven LAN with Security Requirements

The decision to use a LAN for implementation of security functions was another major mistake. In the early 1980s the security procedures required of WIS were well beyond the state of the art for commercial local area networks. LANs were still under study by the standards committees of the Institute of Electrical and Electronic Engineers. The first commercial LAN standard, approved in 1985, did not offer the security elements required for WIS. Even today the LAN approach adopted by GTE for WIS probably could not be pursued on fixed-price contract. Though a number of LAN configurations have since been standardized and there are several competing products for each, a LAN with the security requirements mandated in the WIS RFP would still require substantial additional research and development. GTE's choice of a dual-mode, dynamically reconfigurable LAN is also difficult to rationalize. Though it may have been considered a hedge against uncertainties in the evolution of token-ring

networks, its complexity added more technological burdens to the program.

The WIS security specification required an advanced technology design that the committee believes encouraged GTE to choose a novel proposal presented by a small, unproven business. The design never worked properly and was eventually scrapped. Compounding the error, GTE procured complex security programs and other features from a contractor with little experience in the field. This contractor later decided not to continue the effort. Legal action was required to obtain the contracted equipment. The special network-security concept was costly in terms of schedule and resources, and it ultimately failed. It was later replaced in the IBM message handler by a commercially available authorization and security system based on the Federal Encryption Standard DES-2.

WIS was apparently considered an ideal program for which to require the use of COTS hardware and software. However, the RFPs described many features not available at the time in the commercial marketplace. The contractors placated the SPO with proposed COTS "solutions" but recognized that COTS equipment could not satisfy the baseline system requirements. The low bids submitted in response to the LAN and AHMS RFPs should have been adequate warning to SPO that the supporting technology was still not out of the developmental stage, let alone in the marketplace as a mature commercial product. The committee believes the WIS managers either did not appreciate these indicators or ignored them.

4

LESSONS LEARNED

Two briefers independently recalled the comment by a former WIS acquisition manager: "Well, it ain't rocket science!" Information systems were mistakenly regarded as a less challenging undertaking than rocketry; in fact, distributed information systems involving many large, heterogeneous computer complexes -- such as WIS -- are far less well understood than rocketry today. This perception was the foundation of the problems encountered in the effort to modernize WWMCCS. If no other lesson is learned from the WIS experience other than to appreciate the technical complexity of advanced C^3 upgrades and the need to manage them as carefully as cutting edge weapon systems, this exercise will have been meaningful.

PROGRAM MANAGEMENT

Acquisition of complex information systems requires a very high degree of experience and cooperation on the part of management, procurement, technical, and user personnel. Only a disciplined acquisition process can protect complicated system improvements from the technological and requirements uncertainties inherent in major C^3I programs. Once an application is automated, information systems are generally modernized rather than completely replaced. The WIS experience is one of many failed information system upgrades that suggest traditional management practices frequently cannot cope with evolving user requirements, operator training changes, and many other issues.

Users and acquisition commands must cooperate to shepherd programs through this forbidding bureaucratic terrain. Coordination among these communities is necessary in order to create the sufficient "critical mass" of resources and talent to adequately perform system engineering, simulation, or modeling. Acquisition management personnel alone cannot predict or resolve practical limitations involved in dealing with particular system configurations. All this suggests that a more organic form of cooperation is necessary.

The committee identified three primary management failures in the WWMCCS modernization program.

1. Fundamental principles of business and management were misunderstood, violated, or simply ignored. This was exemplified by:

a. the divided program management, which caused unnecessary competition, confusion, communication problems, and contradictory direction; and

b. assignment of lead agency responsibility to the Air Force as opposed to DCA, which had developed and was operating the baseline system.

2. Technical challenges were grossly underestimated (i.e., COTS technology was mandated, but not available). This was exemplified by:

a. the mid-stream decision to switch the high-level programming language from COBOL to Ada; and

b. the selection of a LAN architecture that called for use of several unproven technologies and approaches (i.e., dynamically switching network employing both token-ring and Ethernet-type formats and integration of strict DoD security provisions on a nominally COTS system).

3. Efforts to shorten the established major systems acquisition process frequently resulted in a failure to perform the system engineering analyses essential to a C^3 modernization program. This was exemplified by:

a. the failure to revise the baseline system requirements and architecture as technical obstacles emerged;

b. the failure to provide adequate responsibility to the assigned system integration contractor; and

c. (in lieu of adequate responsibility) the failure to provide the integration contractor the proper guidance -- for example, complete system engineering analyses from the SETA consultant.

When a SPO is chartered and its staffing authorized, the desired mode of contractor operations (i.e., prime, prime associate-associate(s), or associates) must be carefully specified. A prime-contractor mode requires far fewer management personnel than an associate-contractor structure in which the SPO essentially acts as the prime. Since the SPO does not yet exist when these decisions are pending, determining the acquisition strategy must be assigned to a properly supported SPO cadre, or to an acquisition planning group.

When a prime contractor has been assigned system integration responsibility, the function of the program office is to provide oversight and measure the results. History has demonstrated that it is generally unwise for the government to attempt to perform the integration role. Though this was apparently realized in the acquisition strategy for WIS, the selected integration contractor was given neither proper direction nor sufficient contractual authority to perform these tasks.

THE ADA MANDATE

WIS was encumbered with the 1960s mainframe computers that formed the core of WWMCCS. In addition to OSD pressures to use Ada--regardless of its readiness or the nature of the specific application --WIS was supposed to make maximum use of COTS technology. Ada has not penetrated the commercial marketplace. The difficulty in integrating commercial hardware with an unfamiliar programming language, while at the same time meeting strict information security demands, was a major obstacle in the WIS program.

Standardization of an application programming language (i.e., Ada) is only one of several types of standardization that are related to computer system extendibility, compatibility, and interoperability. Important developments of the past decades, including the IBM personal computer and the UNIX operating system (based on the highly portable C programming language), have introduced the concept of open-system architectures. When applied broadly, open architectures allow managers to acquire interchangeable computers, peripheral devices, and associated software from a variety of qualified and competitive manufacturers. Single-vendor dependency can be reduced, and both COTS and compatible militarized computers can be made available from a wider range of suppliers.

OSD's Ada-dominated computer strategy has cost hundreds of millions of dollars in compiler developments. This approach hinged on the assumption that open commercial architectures would not materialize. However, the pressure from the private marketplace for compatibility across personal computer and workstation product lines has inspired hundreds of software and hardware vendors to overcome the dominance of IBM in the early years of the computer era. Information system research and development in this period centered on mainframe computers. With the emergence of commercial open architectures, the Pentagon's determination to promote Ada as the sole defense programming language will likely jeopardize other programs in the future. The Defense Department should join the open-architecture movement and accept proven, highly efficient, and secure commercial programming languages along with Ada.

RECOMMENDATIONS

1. *Assign management of major programs to a single manager with requisite authority and responsibility.* Systems integration responsibility must also be defined and assigned. In each case, funding, staffing, oversight access, and adequate authority must be ensured. There must be no misunderstanding among program participants or management about which organization has these responsibilities.

2. *Assign management of information system upgrades to the organization that operates or manages the existing system.* If this is not done, the management organization must be a principal participant in the definition of the upgrade.

3. *Conduct comprehensive analyses of the current and projected operational environment of the system, including other systems with which it will operate.* An architectural definition should address principal system interfaces, both internal and external. For example, in the case of information system architectures this may include any or all of the following: hardware architecture, software architecture, data handling architecture, and security architecture.

4. *Ensure that initial system requirements are based on well conceived needs that have been approved by the user.* This effort must be comprehensive and sufficiently thorough to serve as the foundation for the impact analyses conducted in the system engineering process.

5. *Review the system engineering process of the existing system while performing impact analyses for the upgrade.* This analysis should look far enough forward to consider specific hardware and software end items, facilities requirements, and skills and training required for operating, maintenance, and management personnel.

6. *Record and document the system engineering process and the evolution of requirements in order to ensure traceability.*

7. *Do not place constraints (i.e., mandating a specific programming language or the use of COTS technology) until system engineering analyses have been completed.* (See Figure 3.)

8. *Exercise special management and acquisition options such as incremental system development and preplanned product improvements when programs seek to tap rapidly evolving technologies.* To field capable information systems on time, the Defense Department must work near -- but not at -- the leading edge of emerging technology.

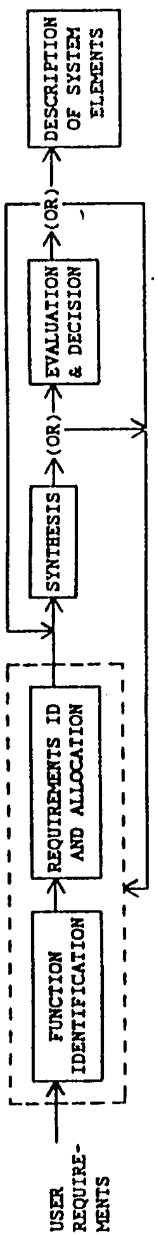
9. *Encourage the use of open-system-architecture approaches.* The alternative will keep DoD 5-10 years behind commercial capabilities.

10. *Design and circulate a clear acquisition strategy.* The acquisition strategy for large information system upgrades should be piece-wise (evolutionary) in order to accommodate the rapidly changing technology and user requirements. The acquisition strategy must be based on a comprehensive risk assessment. The risk assessment must be regularly updated, with significant changes reflected in alterations to the acquisition plan.

11. *Investigate the commercial marketplace to determine if COTS products meet system requirements before issuing solicitations.* If modifications to COTS items are required, the marketplace should be asked to suggest changes in requirements that would make unmodified COTS items viable. Suggested changes should then be evaluated through the system engineering process in order to reestablish cost, schedule, and performance estimates. If these are acceptable, make the changes in specifications, eliminate development efforts, and solicit COTS bids. If impacts are not acceptable, recognize that a developmental effort is required and reflect it in the formal RFP.

12. *Specify system integration responsibility and assign adequate authority to specific entities in the formal acquisition plan.* Retaining system architecture and integration responsibility in the program office requires resources and skills that are not typically available there.

13. *Avoid issuing firm fixed-price contracts unless requirements are stable and impose no technological uncertainties.*



BASIC DOCUMENTATION	FUNCTIONAL FLOW BLOCK DIAGRAMS (FFBD)	REQUIREMENTS ALLOCATION SHEETS (RAS)	CONCEPT DSCRPTN. SHEETS (CDS)	TRADE STUDY REPORTS (TSR)	DESIGN SHEETS (DS)
	Identify & Sequence Functions That Must Be Accomplished To Achieve System Or Project Objectives. Dvlp. The Basis For Establishing Inter-system Functional Interfaces and Identify System Relationships.	Define The Reqmts. & Constraints For Each Of The Functions And Relate Ea. Reqmt. To The Sys. Elements Of a. Equipment b. Facilities c. Personnel d. Procedural Data e. Computer Software	Constrain The Designer To Stop At A Point In The Cycle And Create At The Gross Level A Design Or Synthesis Mtg. The FFBD, RAS, TLS Reqmts. And Constraints.	Select, Evaluate And Optimize Promising Or Attractive Concepts. Document The Trade-Off & Supporting Rationale. Consider All Possible Solutions Within Framework Of Requirements.	Define, Describe & Specify Performance, Design And Test Criteria For The Sys. Elements. a. Equipment b. Facilities c. Personnel d. Procedural Data e. Computer Software
		TIME LINE SHEETS (TLS)	SCHEMATIC BLOCK DIAGRAMS (SBD)		FACILITY INTERFACE SHEETS (FIS)
		Present Critical Functions Against A Time Base In The Required Sequence Of Accomplishment.	Develop And Portray Schematic Arrangemt Of Sys Elements To Satisfy Sys. Reqmts		Identify Environmental & Physical Interfaces Betwn. Equipmt. & Facilities On An End Item Basis.

FIGURE 3 : Process and Basic Documentation for System Engineering
(Derived from DoD Directive 5000.1, February 23, 1991)

APPENDIX A

DOCUMENTATION ON WIS ARCHITECTURAL DESIGN

An architectural design includes both hardware and software considerations. The underlying system upon which all applications depend consists of not only hardware but also software such as the operating system, language run-time-systems, communication protocols, drivers, and support for the interface to operators, users, and maintenance personnel. The following sections describe the chronology of the WWMCCS architectural design and illustrate results of the lack of a central coordinating architect.

Original Program Organization

Three early reports on analysis of WWMCCS capabilities were issued:

- *WWMCCS Architecture* [IBM, 1976]
- *WIS Architecture* [MITRE Corporation, 1976]
- *WWMCCS Information Needs Analysis* [DCA, 1980]

These concluded that hardware, software, and supporting communications in the WWMCCS then in operation needed significant upgrading.

Substantial outlines of a new system architecture for the WWMCCS began to appear in a 1981 report prepared by the DCA in response to pressures by the House of Representatives for a plan. The new architecture would be modular so that manageable pieces of each site's configuration could be converted, thereby minimizing operational impact. It would provide separate clusters of hardware and software to support each of the four functional families identified by the JCS.

In January 1983 the WIS acquisition plan stated "... virtually all the equipment acquired for WIS will be commercially available, off-the-shelf hardware."[1] This statement does not take into account the unique needs generated by the WIS security requirements.

[1] WIS Acquisition Plan, January 12, 1983, p. 10.

On June 10, 1983, the Director of Defense for Research and Engineering issued DoD Directive 5000.31 (revised), "Interim DoD policy on Computer Programming Languages," which stated that Ada shall become the single, common computer programming language for defense mission-critical software applications.[2] The WIS development was one of the first programs in which this directive was implemented.

In early 1986, following review by the Defense Systems Acquisition Review Council, a number of decisions were made, the effects of which virtually crippled the WIS program:

- The WIS Network Authentication System (WISNAS) was adopted, providing security control at a single, centralized terminal and simplifying log-on procedures for users. The WISNAS would require complex software not available in the commercial sector.

- The Honeywell recommendation that new DoD communication protocols be compatible with the initial increment of Block A was accepted. This step would have mandated a simultaneous cut-over of Honeywell mainframes worldwide since the new protocols were incompatible with those previously in use.

In October/November 1986 a "Red Team" consisting of representatives from MITRE Corporation, the SPO, and GTE gave briefings on their study of the WIS Common User Contract, which is the term used for the contracts awarded to IBM. After considering hardware, software, user requirements, security, and performance, the team concluded that IBM's course at the time would not yield an acceptable AMHS and recommended a number of actions:

- the government should clarify the WIS concept of operations;

- IBM should conduct new task analyses and redesign AMHS;

- the government should resolve requirements conflicts in the areas of COTS, Ada, and system integration;

- GTE, with IBM support, should focus on performance issues

[2] 1988 WIS Block A Decision Coordination Paper, from JPMO, p. 2-2.

regarding the Database Management System (DBMS), LAN, and workstation; and

- the government should address security issues and Block B evolution.

As late as March 1987, there remained disagreement over specifications for the AMHS. A year elapsed before specification issues were resolved.

Post-Reorganization

- A 1988 JPM paper states "The architectural approach defined in the July 1982 OSD Report to Congress will be the basis for continuing program development."[3]

- A 1988 JPM paper summarizes comparisons of alternative subsystems for communication protocols, LANs, network configurations, and AMHS systems, both for Block A and Block B.[4]

- An August 4, 1988, MITRE Corporation briefing includes architecture overviews, workstation configurations, interfaces, expansion options, printer characteristics, operating environment, and software items ranging from the multitasking/multiuser operating system through security capability, Ada, libraries, MS-DOS execution environment, and applications software.

- The 1988 Joint Ad Hoc Working Group recommends promulgating an open-systems architecture policy.[5]

[3] 1988 WIS Block A Decision Coordinating Paper, JPMO.

[4] 1988 WIS Block A Decision Coordinating Paper, JPMO.

[5] 1988 Report of the Joint Ad Hoc Working Group (Air Force, DCA, U.S. Transportation Command, JS, and the ASD/C^3I)

APPENDIX B

ABBREVIATIONS AND ACRONYMS

ADP	Automated Data Processing
AFSC	Air Force Systems Command
AMHS	Automatic Message Handling System
ASD/C^3I	Assistant Secretary of Defense for C^3I
C^2	Command and Control
C^3I	Command, Control, Communications, and Intelligence
COTS	Commercial-Off-The-Shelf
CSAF	Chief of Staff of the Air Force
DAB	Defense Acquisition Board
DBMS	Database Management System
DCA	Defense Communications Agency
DoD	Department of Defense
ESD	Electronic Systems Division
FY	Fiscal Year
GTE	General Telephone and Electronics
IBM	International Business Machines
JCS	Joint Chiefs of Staff
JDSSC	Joint Data Systems Support Center
JMENS	Joint Mission Element Need Statement
JOPES	Joint Operational Planning and Evaluation System
JPM	Joint Program Manager

JPMO	Joint Program Management Office
LAN	Local Area Network
OSD	Office of the Secretary of Defense
RDT&E	Research, Development, Test, and Evaluation
RFP	Request For Proposal
RMS	Reliability, Maintainability, and Supportability
ROC	Required Operational Capability
SAF	Secretary of the Air Force
SETA	System Engineering Technical Assistance
SPO	System Program Office
SRA	System Requirement Analysis
USD(A)	Undersecretary of Defense for Acquisition
USTRANSCOM	U.S. Transportation Command
WAM	WWMCCS Automated data processing (ADP) Modernization
WIS	WWMCCS Information System
WISNAS	WIS Network Authentication System
WWMCCS	Worldwide Military Command and Control System